

# **1220 QUANTULUS**

## **The Ultra Low Level Liquid Scintillation Spectrometer**

PerkinElmer LAS (UK) Ltd, Chalfont Rd, Seer Green,  
Beaconsfield, Bucks HP9 2FX tel: 0800 896046

[www.perkinelmer.com](http://www.perkinelmer.com)

**John Davies**  
**January 2006**

# Tri-Carb Liquid Scintillation Analyzers

**LSC Excellence for 50 years  
Reliability You Can Count On**



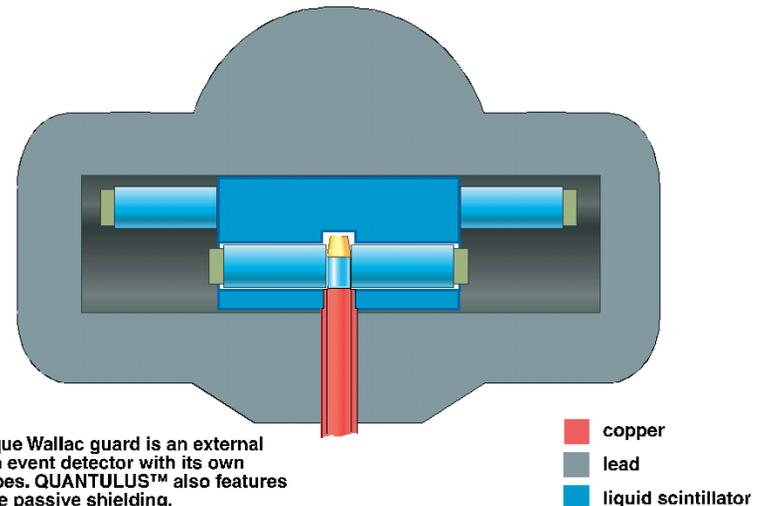
Tri-Carb 2800TR/2900TR/3100TR/3170TR/SL  
Featuring QuantaSmart™ software AND.....

- **The Ultra Low Background Liquid Scintillation Spectrometer**
- **Detects down to environmental levels of alpha and beta radiation**



- **Passive and active rejection of cosmic and other environmental radiation removes atmospheric pressure effect**
- **Low noise, low radioactivity phototubes**
- **Cross-talk rejection**
- **EM noise rejection**
- **Removal of static electricity**
- **4 Programmable Multi Channel Analyzers allow boosted performance**
- **Cooling/temperature stabilization**
- **Alpha/beta separation**
- **Quench level detection with low activity gamma source**

- **Optimal passive attenuation of cosmic and environmental gamma radiation by thick low activity lead shield**
- **Active rejection of residual background by true event detection in an external guard detector, which is optically isolated from the sample**
- **Further background rejection by adjustment of bias threshold, pulse amplitude comparison and pulse shape analysis**



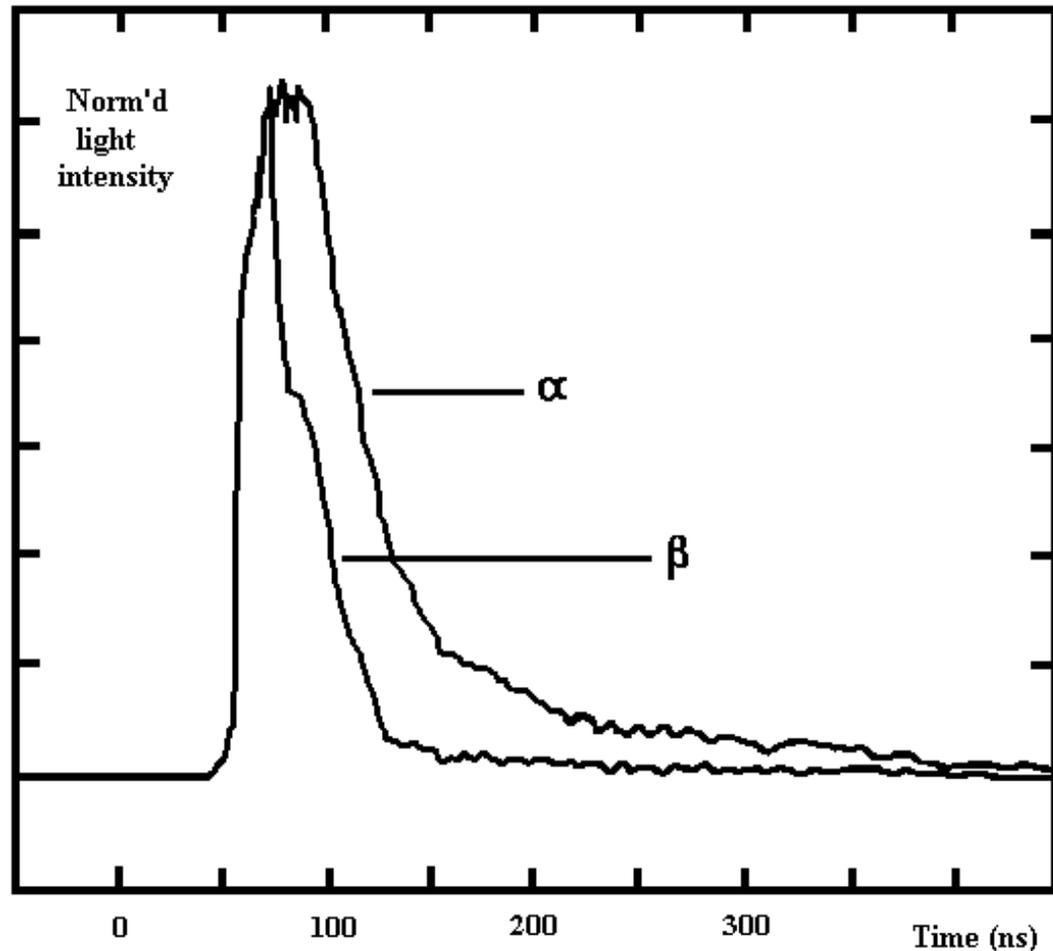
- **Big anticoincident guard detector filled with cocktail all around the sample chamber**
- **Own pair of PMTs for guard and sample chamber**
- **Guard and sample detectors are optically isolated and there is no cross-talk by light or alpha/beta particles**
- **Sample pulse is deemed a background pulse when a simultaneous guard pulse is observed**
- **No limitations on the sample cocktails and fluors**

- **Beta particles**
- **Alpha particles separated in simultaneous counting from beta (Pulse Shape Analysis)**
- **Cerenkov radiation**
- **Conversion electrons**
- **X-rays and Auger electrons**
- **Gamma rays via Compton electrons**
- **Luminescence, fluorescence and chemiluminescence**

- **Coincidence counting with 2 low noise selected phototubes**
- **Detection of EM interference with an aerial**
- **Rejection of static electricity by metal vial holder/light shutter mechanism - deionizer for complete removal of static charge**
- **Noise free cooling by Peltier elements - instrument cooling can be boosted by water circulation**

- **4 simultaneous spectra can be collected from the sample + external standard Compton spectrum**
- **4 automatic counting modes, low energy beta (H-3 etc.), high energy beta (C-14), alpha/beta and user programmed mode**
- **1024 channel spectra can be saved even on rejected counts**
- **Logarithmic presentation allows well defined end point as quench index**

Pulse Shape for Alpha and Beta Events:  
Alpha particles excite triplet states, which decay slower than singlet states by beta particles



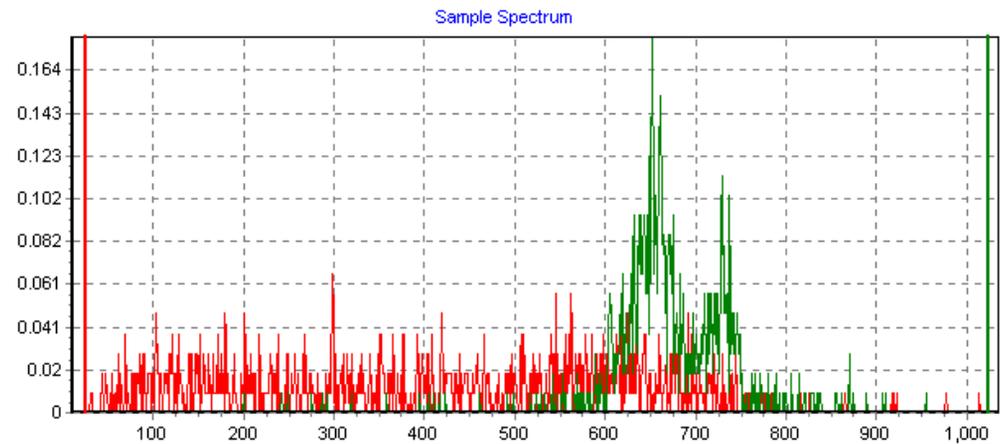
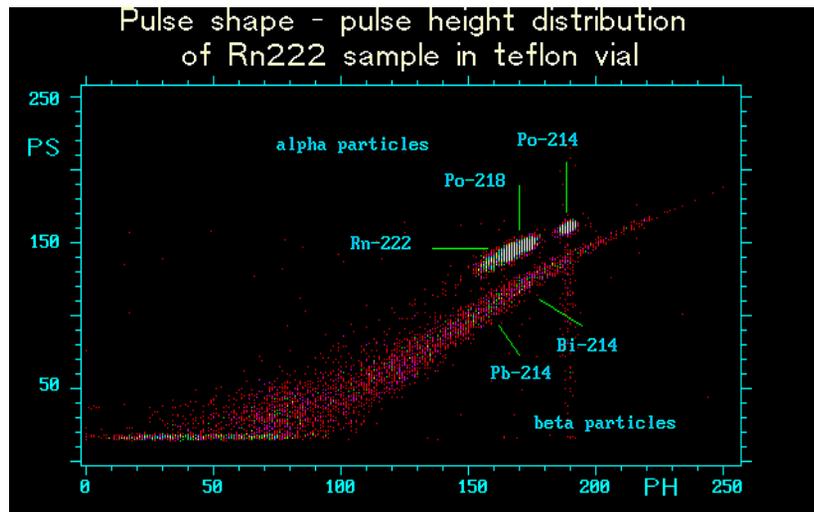
**Pulse Shape Analysis (PSA) refers to the ability to separate  $\alpha$  from  $\beta$  events into their respective spectra in a mixed sample.**

- ◆ **PSA introduced as the first commercial  $\alpha/\beta$  analyzer in LSC's in 1986 by Wallac**
- ◆ **PSA analyzes the charge in the tail of the pulse and compares it to the main pulse to create an amplitude independent pulse length index**

## **Practical Benefits of Pulse Shape Analysis:**

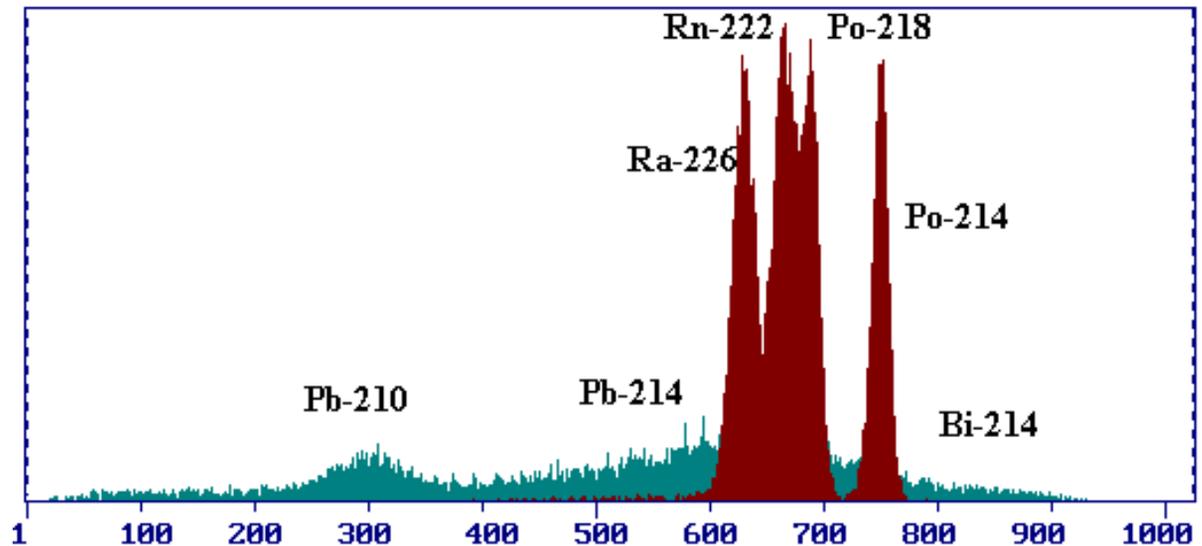
- ◆ **Allows very low  $\alpha$  background as most of background pulses are short and fall into the  $\beta$  spectrum**
- ◆ **Small  $\alpha$  background leads to excellent sensitivity**
- ◆ **Natural decay series can be detected at far better sensitivity by alpha counting than by measuring total  $\alpha/\beta$  signal**

- Radon spectrum in a water sample as a 2D pulse height / pulse shape presentation and as a conventional count rate vs. pulse height presentation



## ➤ Quantulus Pulse Shape Analyzer (PSA) separates alpha and beta signal from mixed radiations

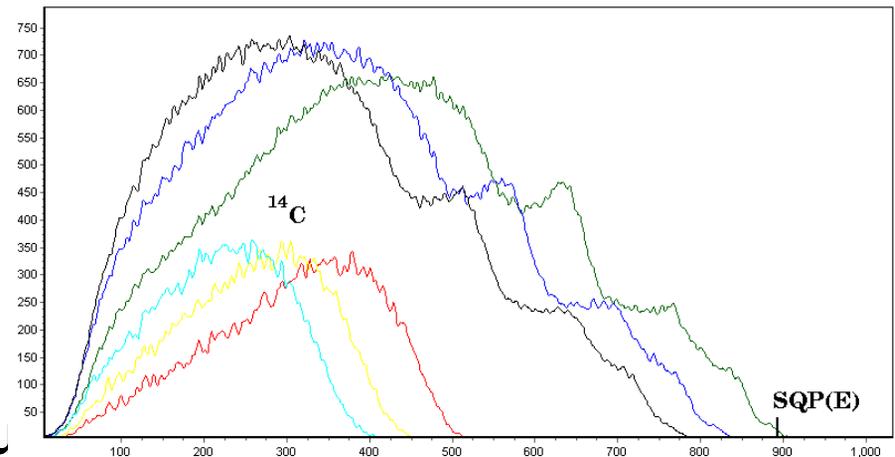
- Provides excellent sensitivity for gross alpha counting (less than 20 mBq/L )
- Backgrounds less than 0.1 CPM for alpha emission
- Less than 0.02 Bq (0.5 pCi) alpha activity easily detected in the presence of 2000 Bq (50 nCi) of beta activity
- Energy resolution as good as 300 keV at 5 MeV at low quench
- PSA can be used for additional background reduction in pure alpha and beta counting for increased sensitivity



- **1)  $4\pi$  counting geometry (equivalent to a geometrical factor = 1)**
- **2) No sample self-absorption (as in the case of planchet counting)**
- **3) Virtually 100 %  $\alpha$  counting efficiency (less than 50 % in planchet counting and solid state  $\alpha$  spectrometry)**
- **4) Simple sample preparation by mixing with a commercial cocktail**
- **5) High throughput - automatic, multiple sample counting**
- **6) Large sample capacity**
- **7) Simultaneous alpha/beta counting (with separation of each spectrum using pulse shape analysis)**
- **8) Ability to detect Radon gas**

- **High bias to reject low energy background events, particularly in glass vials**
- **Pulse Amplitude Comparison (PAC) to reject cross-talk events**
- **Reduced, stable instrument temperature available by a cooling unit - heat sink can be either air or cold water**

- Low activity external  $^{152}\text{Eu}$  standard (37 kBq)
- End point well defined on logarithmic energy scale and correlates well with sample end point
- Fast, non-destructive quench indication
- Works also with low activity,  $\mu\text{Ci}$  label samples



## ***Random sample change - all vials acceptable***

- **Random access to 60 sample positions**
- **Copper-teflon vials for lowest background with volatile solvents**
- **Ordinary plastic vials good with safe cocktails**
- **High bias removes glass vial Cerenkov background due to low K-40 activity**
- **Smaller vials in adapters**



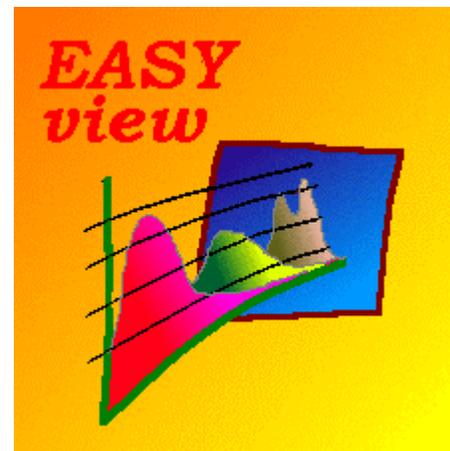
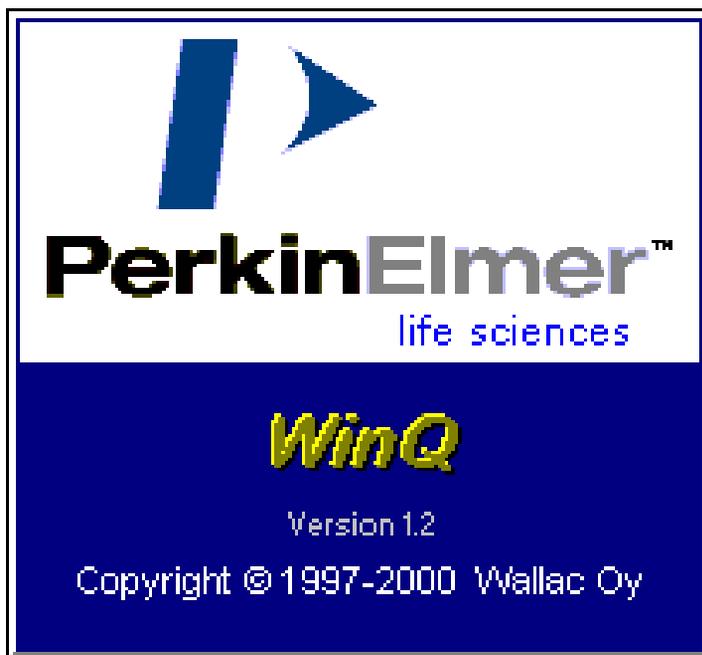
- **Drinking water analyses for Rn, Ra, U, gross alpha/beta**
- **Food analysis for strontium/yttrium**
- **Radiation fallout studies (Sr-90, Cs-137, plutonium)**
- **Ground water circulation and oceanographic studies**
  - **Radiocarbon dating of archaeological and art samples (C-14)**
- **Adulteration studies in art, wine and liquors (C-14)**
- **Plant growth and pesticide studies (C-14, P-32, P33)**
- **Biosynthesis pathways (C-14, P-32, P-33)**

- **Nuclear power effluent discharge monitoring (H-3, C-14)**
- **Radioactive waste monitoring (H-3, C-14, Pu)**
- **Decontamination (H-3, C-14, Pu, etc.)**
- **Nuclear reactor dismantling (NPP's, submarines, H-3, C-14, Ni-63, Fe-55)**
- **Oil well logging, oil production process (H-3, C-14)**
- **Biological studies with reduced radiation dose (H-3, C-14)**

- **Beta backgrounds typically from 2 CPM (high beta energies) down to 0.5 CPM in the best environments (H-3)**
- **0.5 Bq/L H-3 (5 TU) in 500 min direct counting**
- **Up to 65000 year old archaeological samples**
- **Sizes down to 0.3 mL benzene**
- **Excellent Cerenkov and alpha performance - best backgrounds 0.6 CPM and 0.05 CPM**

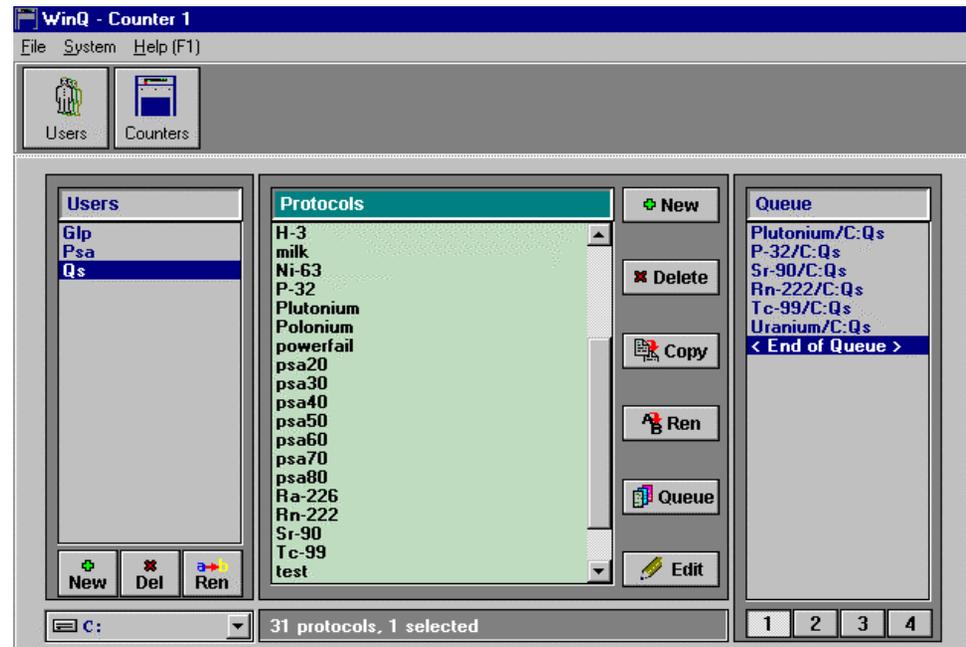
- **Well proven reliability already for 21 years**
- **400 recorded publications with Quantulus**
- **32 % of Quantulus labs have more than just one Quantulus LS spectrometer**
- **Waikato 10 units, Belfast 7 and Tucson 5 units (radiocarbon dating), Vienna (food control lab) 5 units**

- runs in Windows 95, NT4 and XP

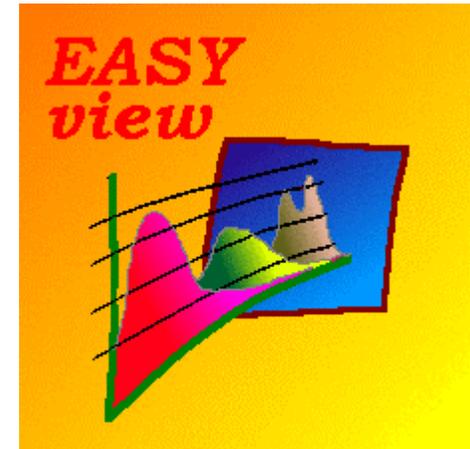


## 1220-307 WinQ, Quantulus user interface in Windows

- up to 4 instruments to one PC
- live display of spectra
- unlimited number of protocols
- default MCA settings + own ones
- controls any Quantulus



- **6 spectra on screen, log & lin**
- **dual label DPM, 3over2 method**
- **activity calculation, C-14 age**
- **spreadsheet included**
- **noise filtering, zooming**
- **outlier identification & rejection**





<http://www.perkinelmer.com>

Homepage for more information and direct  
communication